IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Japanese Application of

Yasuo SAKABA et al.

Japanese Patent Application No.: 2002-268143

Filing Date: September 13, 2002

for: "METHOD OF MANUFACTURING MOUNTING SUBSTRATE AND SURFACE MOUNT CRYSTAL OSCILLATOR"

VERIFICATION OF TRANSLATION

Honorable Commissioner of Patents and Trademarks

Washington, D.C. 20231

Sir:

Junichi TANAKA of 18-24, Maeharacho 4-chome, Koganei-shi, Tokyo, Japan, declares:

(1) that he knows well both the Japanese and English languages;

(2) that he translated the above-identified Japanese Application from Japanese to English;

(3) that the attached English translation is a true and correct translation of the above-identified Japanese Application to the best of his knowledge and belief; and

(4) that all statements made of his own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 USC 1001, and that such false statements may jeopardize the validity of the application or any patent issuing thereof.

April 25, 2005 — Date

J. Tanaka — Junichi TANAKA

(translation)

JAPAN PATENT OFFICE

This is to certify that the annexed is a true copy of the following application as filed with this office.

Date of Application:	September 13, 2002
Application Number: [ST. 10/C]	Patent Application No. 2002-268143 [JP2002-268143]
Applicant(s):	NIHON DEMPA KOGYO CO., LTD.

September 8, 2003

Commissioner,
Japan Patent Office

Yasuo IMAI (Seal)

Shussho No. Shusshotoku 2003-3073210

[Document Name] Patent Application

[Docket Number] P2002070

[Filing Date] September 13, 2002

[To] Kozo OIKAWA, Commissioner, Patent Office

[Inventor]

[Address or Domicile] c/o NIHON DEMPA KOGYO CO., LTD., 1275-2, Oaza Kamihirose, Sayama-shi, Saitama

[Name] Yasuo SAKABA

[Inventor]

[Adress or Domicile] c/o NIHON DEMPA KOGYO CO., LTD., 1275-2, Oaza Kamihirose, Sayama-shi, Saitama

[Name] Masakazu NISHIWAKI

[Applicant for Patent]

[Identification Number] 000232483

[Name or Appellation] NIHON DEMPA KOGYO CO., LTD.

[Representative] Toshiaki TAKEUCHI, President

[Indication of Official Fees]

[Advance Deposit Record Number] 015923

[Amount paid] 21000

[List of Materials submitted]

[Material Name] Specification 1

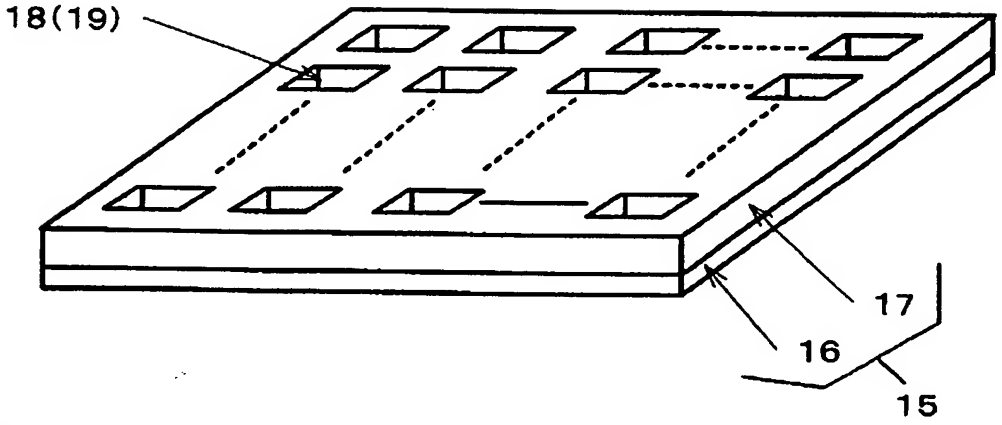
[Material Name] Drawings 1

[Material Name] Abstract 1

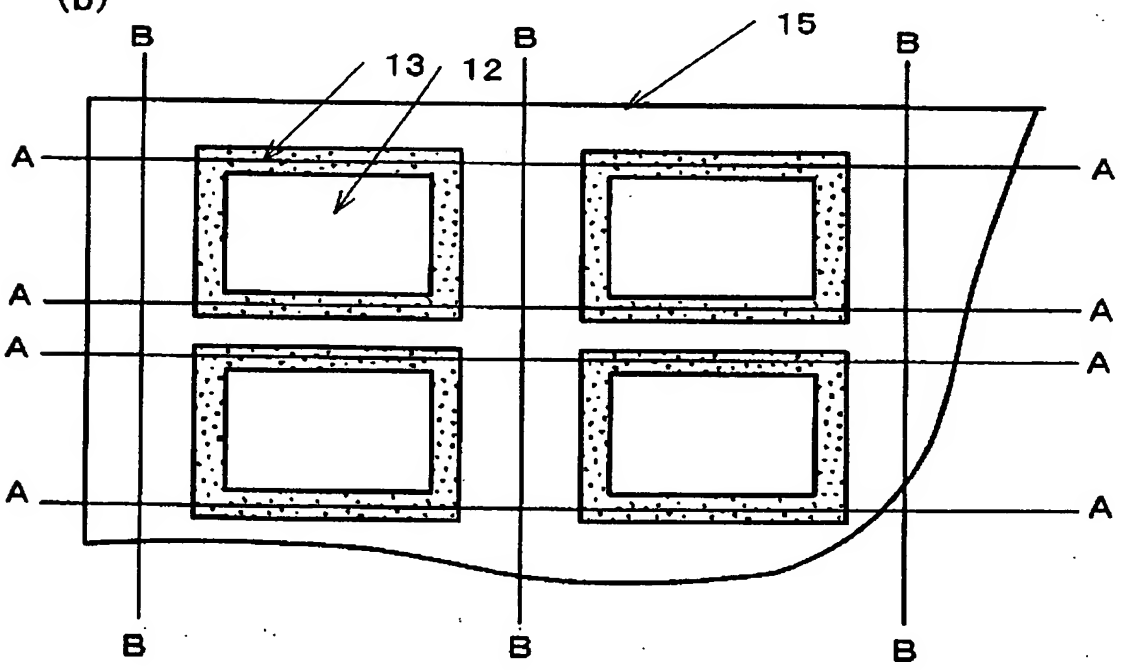
[Proof] Requested

[Document Name] Drawings
[Fig.1]

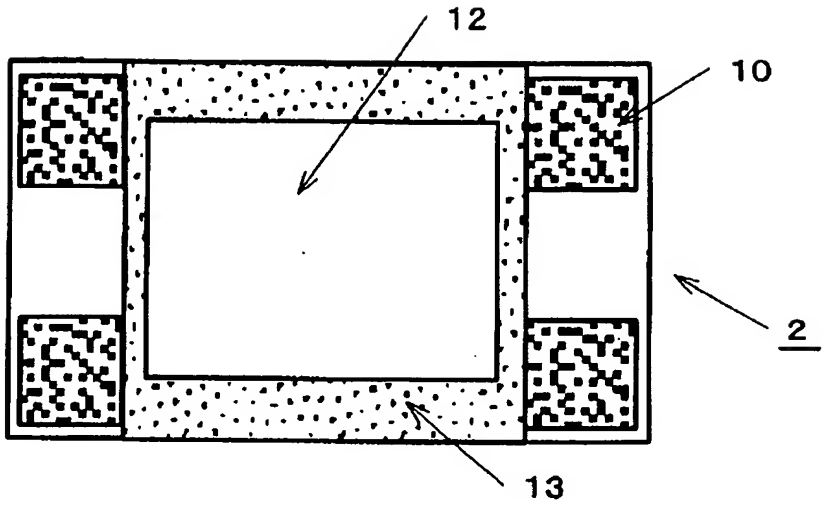
(a)



(b)

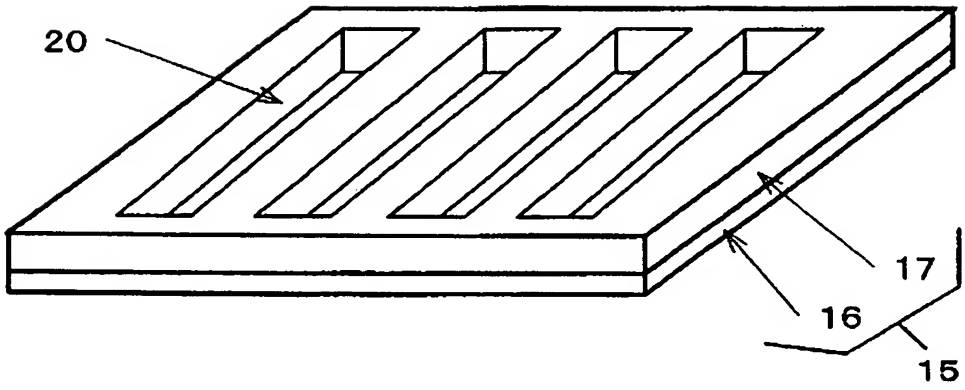


[Fig.2]

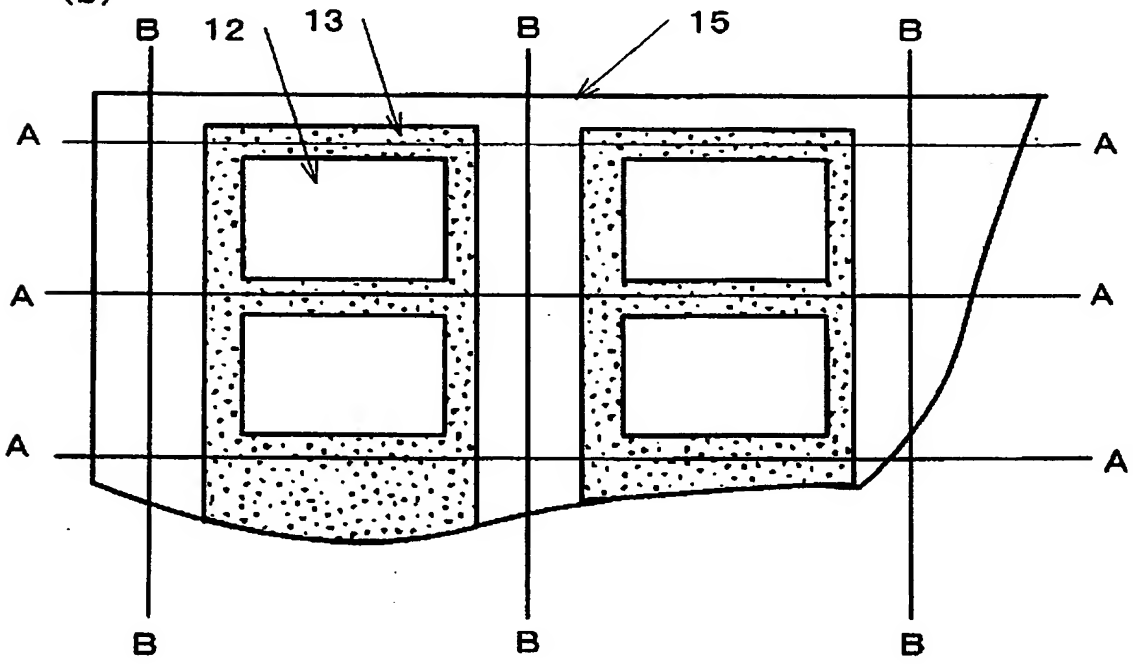


[Fig.3]

(a)

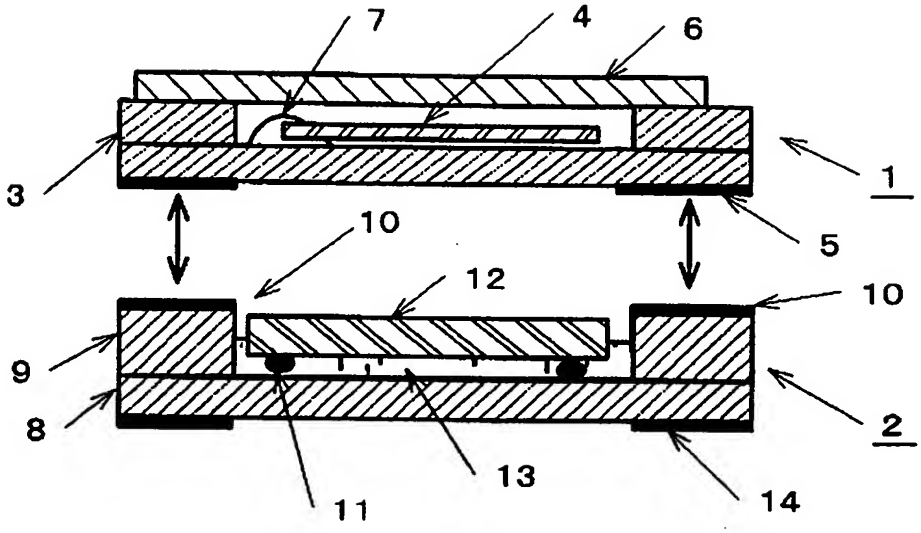


(b)

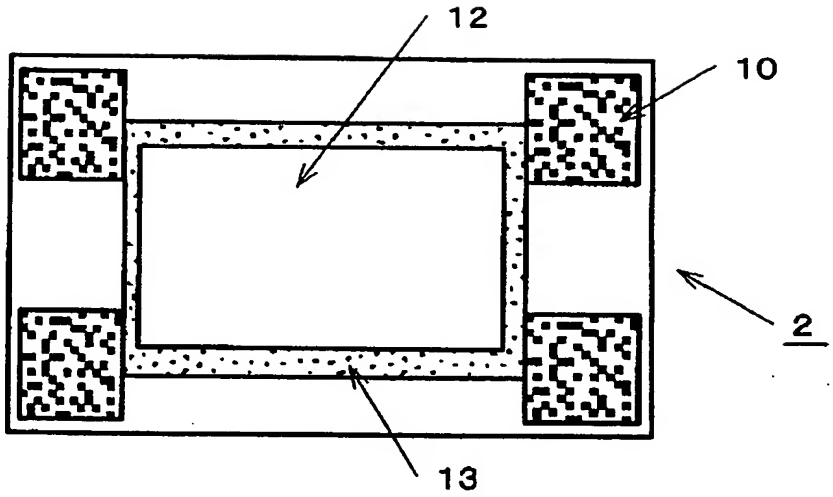


[Fig.4]

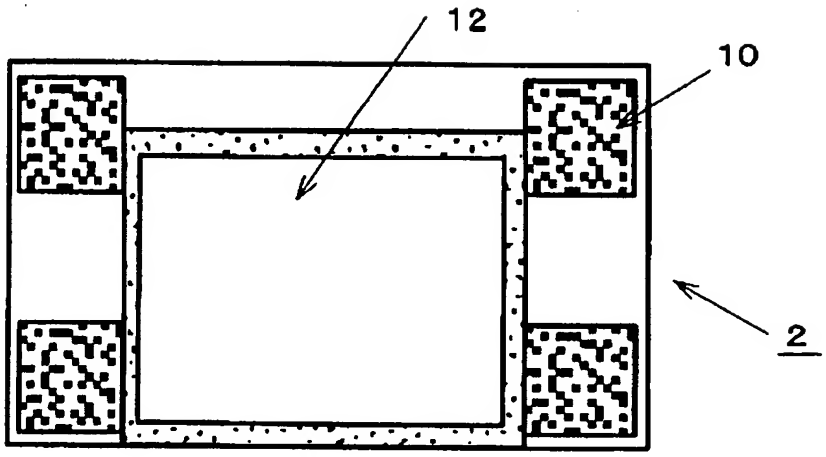
(a)



(b)



[Fig.5]



[Document Name] Specification

[Title of the Invention] Method of manufacturing mounting substrate and surface-mount type crystal oscillator

[Claims]

[Claim 1] A method of manufacturing a mounting substrate accommodating therein an IC chip for use in a surface-mount type crystal oscillator and adapted to be joined to a bottom surface of a crystal unit, the method comprising the steps of:

accommodating the IC chip in a recess with a bottom wall and a frame wall;

filling said recess with a resin for protecting said IC chip; and

after said filling, cutting away at least one side of said frame wall.

[Claim 2] A surface-mount type crystal oscillator in which a mounting substrate manufactured by a method according to claim 1 is joined to a bottom surface of a crystal unit.

[Detailed Explanation of the Invention]

[0001]

[Technical field to which the invention pertains]

The present invention is in the industrial technical field of surface-mount type crystal oscillator (hereinafter referred to as surface-mount oscillator) in which a mounting substrate is joined to a reverse surface of a crystal unit, and more particularly relates to a method of manufacturing the mounting substrate.

[0002]

[Prior art]

(Background of the invention) Since surface-mount oscillators are small in

size and weight, they are widely used as a frequency reference source in communications devices such as cellular phones or the like. Particularly, a surface-mount oscillator of a temperature-compensated type (so-called TCXO) is suitable for use as a reference source in portable devices because it generates a stable oscillating frequency in mobile environments that undergo large temperature changes. One known surface-mount oscillator is of the joined type (see, Japanese Patent No. 2974622).

[0003]

(An example of the prior Art) FIGs. 4(ab) are views explaining an example of the prior art, FIG. 4(a) is a cross sectional view of a surface-mount oscillator, and FIG. 4(b) is a plan view of a mounting substrate.

The surface-mount oscillator comprises crystal unit 1 and mounting substrate 2. Crystal unit 1 accommodates crystal blank 4 in substantially rectangular casing 3 having a recess, both sides of an end of crystal blank 4 being electrically and mechanically connected to connecting electrodes. Casing 3 has crystal terminals 5, which are at least electrically connected to crystal blank 4, at the four corners of a bottom surface of casing 3. In the figure, numeral 6 indicates a cover, and 7 an electrically conductive adhesive.

[0004]

Mounting substrate 2 has a substantially rectangular flat plate shape which is essentially identical to or slightly larger than crystal unit 1, and comprises bottom wall 8 and frame wall 9 formed on outer peripherals of the four sides of bottom wall 8. These walls are made of baked ceramics with frame wall 9 having an opening and laminated on bottom wall. Mounting substrate 2 has crystal receiving terminals 10 at the four corners on the

upper surface of frame wall 9 with an open side in alignment with respective crystal terminals 5.

[0005]

IC ship 12 having a plurality of terminals (not shown) on one principal surface thereof is fixed to bottom wall 8 of mounting substrate 2 by ultrasonic thermo-compression bonding with bumps 11, for example, interposed therebetween. Resin 13 for protecting IC chip 12 is poured and filled. IC chip 12 is a high-functionality IC chip and incorporates therein an oscillating circuit, a temperature compensating mechanism and a PLL control circuit.

[0006]

In the surface-mount oscillator, a plurality of oscillating frequencies are provided by the temperature compensation and PLL control. Mounting terminals 14 for surface mounting are provided on a bottom surface of mounting substrate 2. The bottom surface of crystal blank is then opposed to the open side of mounting substrate 2, and crystal terminals 5 and crystal receiving terminals 10 are bonded to each other by solder (not shown) or the like.

[0007]

[Problem to be solved by the Invention]

(Disadvantages in the prior art) In the surface-mount oscillator with the above arrangement, since IC chip 12 is a high-functionality IC chip, the outer shape of the IC chip becomes larger than the case of an ordinary TCXO. Therefore, as more and more efforts are made to reduce the size of the outer planar shape of the surface-mount oscillator, it becomes more and more difficult to place IC chip 12 in the recess.

[0008]

To overcome this difficulty, it is proposed that one side of frame wall 9 is removed to form an open frame thereby increasing the area of the bottom of the recess for accommodating an IC chip therein, as shown in FIG. 5 (Japanese Patent Application No. 2000-228801). In this case, however, when a resin is poured, the resin tends to flow out through the open frame thereby causing a defect such as a poor appearance and reduction in the productivity.

[0009]

(Object of the invention) It is an object of the present invention to provide a method of manufacturing a mounting substrate and surface-mount crystal oscillator which promote reduction in size by accommodating an IC chip and improve the productivity.

[0010]

[Means for solving the problem]

The present invention is a method of manufacturing a mounting substrate which comprises the steps of accommodating the IC ship in a recess with a bottom wall and a frame wall, filling the recess with a resin for protecting the IC chip, and after the filling, cutting away at least one side of the frame wall. Further, a surface-mount oscillator is obtained by bonding this mounting substrate to a bottom surface of a crystal unit.

[0011]

Since at least one side of the frame wall is cut away, the IC chip can be thus accommodated to promote the reduction in the size. Since the frame wall is cut away after the filling of the resin, the flowing out of the resin is prevented. Since this mounting substrate is bonded to the bottom surface of the crystal unit, a surface-mount oscillator which maintains its reduced

size can be obtained. Hereinafter, an example of the present invention will be explained.

[0012]

[First example]

FIG. 1 is a view explaining a mounting substrate according to a first example of the present invention. FIG. 1(a) is a view of a sheet substrate and FIG. 1(b) is an enlarged fragmentary plan view. It should be noted that parts which are identical to those shown in the prior art example are denoted by identical reference numerals and the explanation thereof is simplified or omitted.

Mounting substrate 2 is formed from sheet substrate 15 which has recesses arranged in a two-dimensional array of rows and columns. Sheet substrate 15 is unitarily formed by laminating bottom wall sheet 16 and side wall sheet 17 and baking the respective green sheets of ceramics.

[0013]

Bottom wall sheet 16 has a flat plate shape. Frame wall sheet 17 has a two-dimensional array of openings (windows) 18 defined therein and defines a large number of recesses together with bottom wall sheet 16. It should be noted that crystal receiving terminals 10 and mounting terminals 14 which are unitarily baked together with these wall sheets are omitted in the figure.

[0014]

First, IC chips 12 are fixed to the bottom wall of bottom wall sheet 16 in respective recesses 19 by ultrasonic thermo-compression bonding with bumps. Thereafter, resin 13 for protecting IC chips 12 is poured into each recess 19, filling up recesses 19.

[0015]

After resin 13 is cured, sheet substrate 15 including resin 13 is severed along lines A-A on the longer sides of recesses 19 in sheet substrate 15. Then, sheet substrate 15 is severed from above frame wall sheet 17 along lines B-B intermediate between respective recesses 19.

[0016]

In this manner, as shown in the plan view of FIG. 2, sheet substrate 15 is divided into individual mounting substrates 2, each of which is free of frame walls along both longer sides and filled with resin 13. Then, as described above, each of mounting substrates 2 is joined to the bottom surface of crystal unit 1, thus completing a surface-mount oscillator.

[0017]

According to the above process of manufacturing a mounting substrate, since the two sides of frame wall 9, which are opposing longer sides defining a recess, are removed, the recess has an increased bottom area. Therefore, large-size IC chip 12 can be placed on the bottom wall.

[0018]

Since the resin is poured to fill up the recess before sheet substrate 15 is cut off, the flowing out of the resin is prevented. Thus, the standard for outer appearance or the like is satisfied and the productivity is improved. Since the mounting substrate is bonded to the bottom surface of a crystal unit, efforts to reduce the size of the surface-mount oscillator are promoted.

[0019]

[Second example]

FIG. 3 is a view explaining a mounting substrate according to a second example of the present invention. FIG. 3(a) is a view of a sheet

substrate and FIG. 3(b) is an enlarged fragmentary plan view. It should be noted that parts which are identical to those shown in the above example are denoted by identical reference numerals and the explanation thereof is simplified or omitted.

In the second example, frame wall sheet 17 laminated on bottom wall sheet 16 is provided with a plurality of grooves 20, each of which is closed at opposite ends thereof in the direction of shorter sides of the mounting substrate. A plurality of IC chips 12 are fixed in groove 20. Then resin 13 is poured and filled up the groove.

[0020]

Next, after resin 13 is cured, sheet substrate 15 including resin 13 is severed along lines A-A at positions between adjacent IC chips 12 in the direction of the longer side of sheet substrate 15. Then, sheet substrate 15 is severed from above frame wall sheet 17 along lines B-B intermediate between the recesses of sheet substrate 15.

[0021]

According to such a process, since the two sides of frame wall 9, which are opposing longer sides defining a recess of mounting substrate 2, are removed as with the case of the first example, the recess has an increased bottom area. Therefore, large-size IC chip 12 can be placed on the bottom wall. The flowing out of the resin is prevented. The productivity is improved and efforts to reduce the size of the surface-mount oscillator are promoted.

[0022]

[Other features]

In each of the above examples, frame wall 9 is removed from the two confronting longer sides. However, the present invention can be applied to the cases where frame wall 9 may be removed from only one longer side or may be removed from one or both of the shorter sides. In each of the above examples, a high-functionality IC chip having a large size is arranged. However, the present invention is not limited to this. If necessary, an electronic component including capacitors or other chip devices may be mounted.

[0023]

Although IC chip 12 is bonded through ultrasonic thermo-compression with bumps, the present invention can be applied to the case where the IC chip is connected by bonding wires (not shown).

[0024]

Although the open side of the mounting substrate is joined to the bottom surface, the present invention can be applied to the case where the closed side of the mounting substrate is joined to the crystal unit. In such a modification, crystal receiving terminals 10 are disposed on the closed side, and the mounting terminals 14 are disposed on the open side. If a high-functionality IC chip is used, then since the number of mounting terminals is increased, the mounting terminals may be of a so-called BGA structure having solder balls or the like.

[0025]

[Advantageous effect of the invention]

Since the present invention has the steps of accommodating an IC chip in a recess with a bottom wall and a frame wall, filling the recess with a

resin for protecting the IC chip, and after the filling, cutting away at least one side of the frame wall, the present invention provides a method of manufacturing a mounting substrate and surface-mount crystal oscillator which promote reduction in size by accommodating an IC chip and improve the productivity.

[Brief explanation of the drawings]

[FIG. 1] Views explaining a mounting substrate according to a first example of the present invention. FIG. 1(a) is a view of a sheet substrate and FIG. 1(b) is an enlarged fragmentary plan view.

[FIG. 2] A plan view of the mounting substrate according to the first example of the present invention.

[FIG. 3] Views explaining a mounting substrate according to a second example of the present invention. FIG. 3(a) is a view of a sheet substrate and FIG. 3(b) is an enlarged fragmentary plan view.

[FIG. 4] Views explaining a prior art example. FIG. 4(a) is an exploded cross-sectional view of a surface-mount oscillator and FIG. 4(b) is a plan view of a mounting substrate.

[FIG. 5] A plan view of a mounting substrate of another prior art example.

[Explanation of reference numerals]

1 Crystal unit; 2 mounting substrate; 3 Casing; 4 Crystal blank; 5 Crystal terminal; 6 Cover; 7 Electrically conductive adhesive; 8 Bottom wall; 9 Frame wall; 10 Crystal receiving terminal; 11 Bump; 12 IC chip; 13 Resin; 14 Mounting electrode; 15 Sheet substrate; 16 Bottom wall sheet; 17 Frame wall sheet; 18 Opening; 19 Recess; 20 Groove.

[Document name] Abstract

[Abstract]

[Problem] To provide a method of manufacturing a mounting substrate and crystal oscillator of the joined type which promote reduction in size by accommodating an IC chip and improve the productivity.

[Solving means] In a method of manufacturing a mounting substrate accommodating therein an IC chip for use in a surface-mount type crystal oscillator and adapted to be joined to a bottom surface of a crystal unit, the method comprises the steps of accommodating the IC chip in a recess with a bottom wall and a frame wall, filling the recess with a resin for protecting the IC chip, and after the filling, cutting away at least one side of the frame wall. The mounting substrate is joined to a bottom surface of a crystal unit to constitute a surface-mount type crystal oscillator.

[Representative drawing] FIG. 1